



Interrelation of neurodynamic indicators with indicators of physical and technical readiness of young footballers of 12-13 and 15-16 years in the preparatory and competitive periods of the annual cycle of the training process

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Abstract

The purpose of the study is to determine the correlation of psycho-physiological functions with indicators of physical and technical readiness of young footballers of 12-13 and 15-16 years in the preparatory and competitive periods of the annual cycle of the training process. *Methods.* 24 football players participated in the study, 12 of them 12-13 years old; 12 football players 15-16 years old. Parameters characteristic for determining the psychophysiological state, indicators of the nervous system's work capacity, and attention indicators were analyzed with the help of computer programs for psychophysiological testing. Also, determination of the level of physical preparedness (running on 60 m, running on 1000 m, shuttle running, pulling on the crossbar, jumping from place), determination of the level of technical preparedness (juggling, impact on range). Testing was carried out at the beginning of the preparatory period and at the beginning of the competition period of the annual cycle of the training process. The gap between the two tests was 3 months. *Results.* In the preparatory period of young footballers 15-16 years, the total number of reliable relationships between psychophysiological indicators and indicators of physical and technical preparedness is lower than that of young footballers 12-13 years in the preparatory and competitive periods. In the competitive period of 15-16 year old football players there is an increase in the number of interconnections between psychophysiological indicators and indicators of physical and technical preparedness compared with the preparatory period. In footballers aged 15-16 in the competitive period, there is an increase in the number of relationships that reflect rapid physical qualities and mobility of the nervous system, the ability to switch attention, the speed of a simple and complex reaction in comparison with the preparatory period and the results of testing the players 12-13 years. *Conclusions.* The obtained data is a reflection of the process of formation of a specific type of football player, when the speed of neurodynamic processes is associated with high-speed and speed-strength physical qualities.

Keywords: football; psycho-physiological indicators; training, training

Анотація

Козіна Ж., Л., Крету М., Сафронів Д.В., Гринь І., Рубан І., Храпов С.Б., Пасічна Т.В. Взаємозв'язок нейродинамічних показників з показниками фізичної і технічної підготовленості юних футболістів 12-13 та 15-16 років у підготовчому та змагальному періодах річного циклу тренувального процесу. *Мета дослідження* – визначити взаємозв'язок психофізіологічних функцій з показниками показників фізичної та технічної підготовленості юних футболістів 12-13 і 15-16 років у підготовчому та змагальному періодах річного циклу тренувального процесу. *Методи.* У дослідженні взяли участь 24 футболіста, з них 12 футболістів 12-13 років; 12 футболістів 15-16 років. Проаналізовано параметри, що характеризують психофізіологічний стан, показники працездатності нервової системи та показники уваги за допомогою комп'ютерних програм для психофізіологічного тестування. Тестування проводилося на початку підготовчого періоду і на початку змагального періоду річного циклу тренувального процесу. Проміжок між двома тестуваннями склав 3 місяці. *Результати.* У юних футболістів 15-16 років у підготовчому періоді загальна кількість достовірних взаємозв'язків між психофізіологічними показниками та показниками фізичної і технічної підготовленості менша, ніж у юних футболістів 12-13 років у підготовчому та змагальному періодах. У змагальному періоді у футболістів 15-16 років спостерігається підвищення кількості взаємозв'язків між психофізіологічними показниками та показниками фізичної і технічної підготовленості у порівнянні з підготовчим періодом. У футболістів 15-16 років у змагальному періоді спостерігається збільшення кількості взаємозв'язків, які відображують швидкісні фізичні якості та рухливість нервової системи, здатність до перемикання уваги, швидкість простої та складної реакції у порівнянні з підготовчим періодом та результатами тестування футболістів 12-13 років. *Висновки.* Отримані дані є відображенням процесу формування специфічного типу футболіста, коли швидкість нейродинамічних процесів пов'язана з швидкісними та швидкісно-силовими фізичними якостями.

Ключові слова: футбол, психофізіологічні показники, тренування, підготовка

Аннотация

Козина Ж., Л., Крету М., Сафронов Д.В., Гринь И., Рубан И., Храпов С.Б., Пасечная Т.В. Взаимосвязь нейродинамических показателей с показателями физической и технической подготовленности юных футболистов 12-13 и 15-16 лет в подготовительном и соревновательном периодах годичного цикла тренировочного процесса. *Цель исследования* - определить взаимосвязь психофизиологических функций с показателями физической и технической подготовленности юных футболистов 12-13 и 15-16 лет в подготовительном и соревновательном периодах годичного цикла тренировочного процесса. *Методы.* В исследовании приняли участие 24 футболиста, из них 12 футболистов 12-13 лет и 12 футболистов 15-16 лет. Методы. В исследовании приняли участие 24 футболиста, из них 12 футболистов 12-13 лет и 12 футболистов 15-16 лет. Проанализированы параметры, характеризующие психофизиологическое состояние, показатели работоспособности нервной системы и показатели внимания с помощью компьютерных программ для психофизиологического тестирования. Тестирование проводилось в начале подготовительного периода и в начале соревновательного периода годичного цикла тренировочного процесса. Промежуток между двумя испытаниями составил 3 месяца. *Результаты.* У юных футболистов 15-16 лет в подготовительном периоде общее количество достоверных взаимосвязей между психофизиологическими показателями и показателями физической и технической подготовленности меньше, чем у юных футболистов 12-13 лет в подготовительном и соревновательном периодах. В соревновательном периоде у футболистов 15-16 лет наблюдается увеличение количества взаимосвязей между психофизиологическими показателями и показателями физической и технической подготовленности по сравнению с подготовительным периодом. У футболистов 15-16 лет в соревновательном периоде наблюдается увеличение количества взаимосвязей, отражающих скоростные физические качества и подвижность нервной системы, способность к переключению внимания, скорость простой и сложной реакции по сравнению с подготовительным периодом и результатами тестирования футболистов 12-13 лет. *Выводы.* Полученные данные являются отражением процесса формирования специфического типа футболиста, когда скорость нейродинамических процессов связана со скоростными и скоростно-силовыми физическими качествами.

Ключевые слова: футбол, психофизиологические показатели, тренировка, подготовка



Introduction

Modern football is one of the most popular sports in the world. It is not coincidental, because football requires the development of both physical qualities and psycho-physiological functions, because complex technical techniques in football can only be carried out with the perfect control of movements of the central nervous system. This is especially true at the stage of technical skill development (Campos, Pereira, Alves, Mineiro, Scorcine, & Madureira, 2017). That is why the training process for young footballers needs to be built taking into account the dynamics of the development of psychophysiological functions of athletes. To do this, it is necessary to determine the peculiarities of the dynamics of psycho-physiological functions of young players of all ages at different stages of the annual cycle of training.

Football requires the development of physical qualities and psycho-physiological functions (Aksoy, & Agaoglu, 2017, Campos, Pereira, Alves, Mineiro, Scorcine, & Madureira, 2017), since complex technical techniques in football can be carried out only with the perfect control of movements of the central nervous system (Figueira, Goncalves, Masiulis, & Sampaio, 2018, Georgy, 2018). For this reason, the authors who were involved with the management of central nervous system movements (Shadmehr, Wise, 2005, Paul, Ganesan, Sandhu, Simon, 2012) consider it necessary to determine the state of the nervous system in the formation of motor skills. The state of the nervous system can be determined by many methods (Korobeynikov, Korobeynikova, Romanyuk, Dakal, Danko, 2017, Korobejnikov, Korobejnikova, Kozina, 2012). In modern studies, psychophysiological methods are often used to determine the state of the athlete's nervous system and the general functional state (Korobejnikov, Korobejnikova, Kozina, 2012, Deary, Der, Ford, 2001, Kozina, Koval, Kovtun, Temchenko, 2015, Hedayatpour, Falla, 2015).

The development of psychophysiological functions is determined by hereditary characteristics (Korobejnikov, Korobejnikova, Kozina, 2012, Cacioppo, Tassinari, Berntson, 2007, Shumway-Cook, Woollacott, 1995). But at the time of the reaction to the visual and auditory stimuli are influenced by the factors of special training. Many researchers (Shumway-Cook, Woollacott, 1995, Lyzohub, Nechyporenko, Pustovalov, Suprunovych, 2016, Ilin, 1974) found that sports such as sports games (basketball, volleyball, football, etc.), martial arts influence development psychophysiological functions. This is followed by a reduction in the response time to the visual and auditory stimuli,

increased speed of operational thinking, reduced response time of choice, increased stability of reaction time with multiple tests for determining the reaction time, reducing the number of errors in response to various stimuli (Kozina, 2005, Kozina, Cieslicka, Prusik, Muszkiet, Sobko, Ryepko, Bazilyuk, Polishchuk, Osiptsov, Korol, 2017, Kozina, Grin, & Yefimov, 2010).

Football belongs to sports, in which the success of competitive activities depends not only on the development of motor qualities, but also on the work of the nervous system, which is reflected in increasing the speed of response to various stimuli, the speed of switching attention (Aksoy, & Agaoglu, 2017, Figueira, Goncalves, Masiulis, & Sampaio, 2018, Shadmehr, Wise, 2005). In the process of training young footballers constantly increases the amount of special funds that affect the development of psycho-physiological functions. For the rational management of the training process of young football players of all ages it is necessary to have information on the peculiarities of the dynamics of the development of indicators of physical development, physical and technical preparedness of players (Kozina, 2005, Kozina, Cieslicka, Prusik, Muszkiet, Sobko, Ryepko, Bazilyuk, Polishchuk, Osiptsov, Korol, 2017, Arrieta, Castellano, Guridi, & Echeazarra, 2017, Bolotin, & Bakayev, 2017, Jaafar, Abdul & Ahmad, 2018). These problems are widely covered in modern scientific research. Alturo et al. (2018), da Silva et al. (2019) showed that there are differences in the typology of somato-building in football players of all ages and different regions. Neogi et al. [24] showed the impact of different training systems on the physical, physiological aspects and indicators of physical and technical fitness of young players. But the question remains about the existence of differences in the dynamics of the development of psychophysiological functions in young footballers of all ages. Based on the analysis of literary data, we put forward the hypothesis: there are differences in the dynamics of psychophysiological functions in young football players of all ages under the influence of special training loads, characteristic of football.

Based on the analyzed literature data, we can assume that the psycho-physiological functions are related to the indicators of technical and physical fitness, which depends on the age of athletes and the period of the annual training cycle.

The purpose of the study is to determine the correlation of psycho-physiological functions with indicators of physical and technical readiness of young footballers of 12-13 and 15-16 years in the



preparatory and competitive periods of the annual cycle of the training process.

Subjects and methods

Subjects

24 football players participated in the study, 12 of them 12-13 years old; 12 football players 15-16 years old. All children started to play football in the age of 10-11, that is, the duration of football classes was 1-2 years for football players 12-13 years and 5-6 years for football players 15-16 years old.

Experimental protocol

Initially, the level of psycho-physiological functions, physical and technical preparedness of young football players of 12-13 and 15-16 years at the beginning of the preparatory period of the annual cycle of the training process was determined. Young footballers have been tested for 2 training sessions. On the first day, testing was conducted on the level of technical preparedness. The second day was tested on the level of physical fitness. Psychophysiological testing was conducted on the third day from 17-00 to 19-00.

Young footballers trained in the programs of preparation for competitions according to the standard programs of children's and youth sports schools according to training tasks for 3 months, till the end of the preparatory period and the beginning of the competition period.

The next step was to conduct a re-test at the start of the competition period. Young players again passed tests similar to the first tests to determine the level of physical, technical preparedness and development of psychophysiological functions.

At the next stage, the statistical processing of the data was carried out to identify the characteristics of the dynamics of psychophysiological indicators, as well as the indicators of physical and technical fitness of young athletes. Based on the obtained data, practical recommendations were developed for constructing a training process for young footballers in accordance with the identified peculiarities of physical and technical preparedness and the development of psychophysiological functions.

Determination of the level of physical preparedness

1. Running for 60 m

This test was conducted on treadmills, running from a high start, the assistant coach gives the team "For start! Warning! Rush! ", And at the finish, the coach with the stopwatch determines the time for which the footballers ran, the races were held by two men.

2. Running for 1000 m

This running test was carried out at speed and measured by time, the players started on the starting

line, on the team "Rush!", The players began to move, at the finish the final results were fixed assistant coach.

3. Shuttle run

Conducting this test was on the football field, it was performed 30x4, that is, you need to run 4 times in 30 meters, the start was arbitrary on the whistle, this test was measured in seconds, you need to run as soon as possible distance.

4. Lifting up on the crossbar

The test for physical strength, performed very simply, the young athlete approaches the crossbar, he needs to climb on the crossbar. The test is measured in the quantities of correctly executed repetitions.

5. Jump from place

This test is carried out from place, the player is in front of the line, he has 3 attempts, the best goes off, it is measured in centimeters.

Determination of the level of technical preparedness

1. Juggling. The main task of this test, the player needs to fill the ball so that it does not fall to the ground, it is done by the feet, the athlete must fill the ball as many times as possible.

2. Impact on range. Being out of the line of the field, the player must strike the ball from the run as far as the distance, this distance is measured in meters.

Psychophysiological research methods

Psychophysiological research methods were used to determine the level of attention, ability to concentrate, mental performance, and the speed of reaction. Research of mental working capacity was conducted with the method of Schulte table. The ability to concentrate was studied with the proof-reading (correction) method (Bourdon test) (Iermakov, Kozina, Ceslitska, Mushketa, Krzheminski, Stankevich, 2016, Kozina, Prusik, Görner, Sobko, Repko, Bazilyuk, Kostiukevych, Goncharenko, Galan, Goncharenko, Korol, Korol, 2017, Kozina, Iermakov, Bartik, Yermakova, Michal, 2018).

The following parameters characteristic of the psychophysiological state, typological features of the nervous system, indicators of the nervous system efficiency, and attention indicators ((Iermakov, Kozina, Ceslitska, Mushketa, Krzheminski, Stankevich, 2016, Kozina, Prusik, Görner, Sobko, Repko, Bazilyuk, Kostiukevych, Goncharenko, Galan, Goncharenko, Korol, Korol, 2017) have been set using the computer program "Psychodiagnostics":

– A set of indices for the time of a simple visual-motor reaction (mean of 30 attempts [ms], standard deviation [ms], number of errors); duration of exposure (signal) – 900 ms.



– A set of indicators of a complex visual-motor reaction of selecting 1 element from 3 and selecting 2 elements from 3 (mean value of 30 attempts [ms], standard deviation [ms], number of errors); duration of exposure (signal) – 900 ms.

– A set of indicators of a complex visual-motor reaction of selecting 2 elements out of 3 in the feedback mode, i.e. as the response time changes, the signal delivery time changes. The 'short version' is carried out in the feedback mode, when the duration of exposure changes automatically depending on the response of the subject: after a correct answer, the duration of the next signal is reduced by 20 ms, and after a wrong one, it increases by the same amount. The range of the signal exposure change during the test subject's operation is 20–900 ms, with a pause between exposures of 200 ms. The correct answer is to press the left (right) mouse button while displaying a certain exposure (image), or during a pause after the current exposure. In this test, the time to reach the minimum exposure of the signal and the time of the minimum exposure of the signal reflect the functional mobility of the nervous processes; the number of errors reflects the strength of the nervous processes (the lower these parameters, the higher the mobility and strength of the nervous system). The duration of the initial exposure is 900 ms; the amount of change in the duration of the signals with correct or erroneous responses is 20 ms; pause between the presentation of signals – 200 ms; the number of signals is 50. The indicators are fixed: the average value of the latent period (ms); root mean square deviation (ms); number of mistakes; time of test execution (s); minimum exposure time (ms); time of exposure to the minimum exposure (s).

– A set of indicators of a complex visual-motor reaction of selecting 2 elements out of 3 in the feedback mode, i.e. as the response time changes, the signal delivery time changes. The 'long version' is carried out in the feedback mode, when the duration of exposure changes automatically depending on the response of the subject: after a correct answer, the duration of the next signal is reduced by 20 ms, and after a wrong one, it increases by the same amount. The range of the signal exposure change during the test subject's operation is 20–900 ms, with a pause between exposures of 200 ms. The correct answer is to press the left (right) mouse button while displaying a certain exposure (image), or during a pause after the current exposure. In this test, the time to reach the minimum exposure of the signal and the time of the minimum exposure of the signal reflect the functional mobility of the nervous processes; the number of errors reflects the strength of the nervous processes (the lower these parameters, the higher the mobility and strength of the nervous system). In

addition, the total time of the test reflects a combination of strength and mobility of the nervous processes. The duration of the initial exposure is 900 ms; the amount of change in the duration of the signals with correct or erroneous responses is 20 ms; pause between the presentation of signals – 200 ms; the number of signals is 120. The indicators are fixed: the average value of the latent period (ms); root mean square deviation (ms); number of mistakes; time of test execution (s); minimum exposure time (ms); time of exposure to the minimum exposure (s).

The indicators of mental working capacity were also determined in accordance with the Schulte test. In this test, the subject needs 5×5 tables of 25 digits (from 1 to 25) arranged in a random order, to mark the numbers from 1 to 25. After passing the first table, the second with a different order of digits immediately appears, and so on. In total, the subject passes 5 tables. The reported outcomes were: the time of work on each of the 5 tables (min), the efficiency of work as the arithmetic average of the time of operation on 5 tables (min), the performance of the nervous system as a private time of work on the 4th and 1st tables, and the workability of the nervous system as a private work time for the 2nd and 1st tables.

The response time of the selection for the signals appearing at various points of the screen in a button selection program ('Ermakov test') was also determined (Iermakov, Kozina, Ceslitska, Mushketa, Krzheminski, Stankevich, 2016).

Diagnosis of the psychophysiological state of a person according to the program of measuring the time of the reaction of choosing a point in space: "Select a button" ('Ermakov test').

In this test, the time of the reaction of the choice of a point in space is measured, which includes conducting one series or several series of tests, which according to the algorithm consists of a sequence of actions:

- on the touch screen of the electronic device, displays the image of the object for response, and the object is displayed each time in a new location, the time interval between the appearance of the object is not constant;
- response to the appearance of the object on the screen is carried out by touching the image of the object,
- Sum up the number of items in each series, the number of correct touches and the number of series

Parameters to be recorded: Total test run time; The total number of correct answers; Number of errors.

Statistical analysis



Взаимосвязь психофизиологических показателей, показателей физической и технической подготовленности определялась с помощью корреляционного анализа Пирсона. The processing of indicators was carried out with the help of computer programs - "EXCEL-2016" and "SPSS-17".

Ethical approval

The research related to human use has been complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the authors' institutional review board.

Informed consent

Informed consent has been obtained from the participant included in this study.

It was found that young football players 15-16 years of psychophysiological indicators, indicators of physical and technical preparedness is significantly better than that of football players 12-13 years ($p < 0,05$). But the dynamics of the correlation of these indicators from the preparatory to the competitive period is more pronounced among football players of 15-16 years (Table 1-4).

In the preparatory period, young footballers of 12-13 years found reliable relationships ($p < 0,05$) between the indicators of the latent period of a simple reaction and the time of work on the second table Schult, the efficiency of work in the Ermakov test, the time of shuttle run; between the effectiveness of the Ermakov test and the latent period of the reaction of choice, ball juggling, distances (Table 1). The total number of reliable interrelationships between psychophysiological indicators and indicators of physical and technical preparedness was 12 interconnections.

Results

Table 1

Interconnection of psychophysiological indicators and indicators of physical and technical readiness of young football players 12-13 years in the preparatory period of the annual training cycle

Indicators	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1,00															
2	-0,09	1,00														
3	0,45	-0,26	1,00													
4	-0,09	-0,21	0,20	1,00												
5	0,51*	-0,40	0,60	0,71	1,00											
6	0,32	-0,17	0,42	0,16	0,53	1,00										
7	0,61*	0,17	-0,74	-0,29	-0,64	-0,15	1,00									
8	0,47	0,09	-0,50	-0,55	-0,71	0,11	0,84	1,00								
9	0,04	-0,53	-0,05	0,08	0,00	0,24	0,24	0,42	1,00							
10	-0,16	0,12	-0,36	0,23	-0,14	0,10	0,21	0,26	0,43	1,00						
11	0,65*	-0,09	0,43	0,28	0,68	0,53*	-0,32	-0,35	0,11	-0,31	1,00					
12	-0,15	0,03	-0,08	-0,71	-0,49	-0,17	0,05	0,27	-0,32	-0,50*	-0,41	1,00				
13	-0,03	0,35	-0,13	-0,46	-0,25	-0,22	-0,06	-0,10	-0,84	-0,34	-0,29	0,58	1,00			
14	-0,31	0,35	-0,10	-0,31	-0,27	-0,27	0,02	-0,08	-0,88*	-0,43	-0,41	0,56	0,89	1,00		
15	-0,18	0,40	-0,18	-0,36	-0,29	-0,32	-0,01	-0,11	-0,88*	-0,43	-0,39	0,59	0,91	0,96	1,00	
16	-0,57*	-0,72*	-0,32	-0,30	0,66*	-0,31	0,32	0,35	-0,42	0,06	-0,63	0,41	0,33	0,52*	0,53*	1,00

Notes: 1 - time of the latent period of a simple visual-motor reaction (ms); 2 - time of the latent period of the reaction of selecting 2 objects from 3 (ms); 3 - time of the latent period of the reaction of selecting 2 objects from 3 in the feedback mode (ms); 4 - the minimum signal exposure time in the test with feedback (ms); 5 - total test time with feedback (ms); 6 - time to reach the minimum signal exposure in a test with feedback (ms); 7 - work time on the second table in the Schulte test (s); 8 - work time on the fifth table in a Schulte test (s); 9 - run, 60 m (s); 10 - run, 1000 m (s); 11 - shuttle run 30m x 4 (s); 12 - pull-ups (number); 13 - jump from the spot (m); 14 - ball juggling (number); 15 - Strikes at a distance (m); 16 - Test "Vibir Button" (test Ermakova), 30 s (number); * - the relationship is reliable at $p < 0.05$



In the competitive period in young footballers of 12-13 years, the total number of reliable relationships between psychophysiological indicators and indicators of physical and technical preparedness remained unchanged, and also made 12 interconnections. Reliable relationships ($p < 0,05$) were found between the indicators of the latent period of a simple reaction and the result in a shuttle

run, running at 60 m; between the time of the test with the feedback and running time at 1000 m, sometimes shuttle run, strikes on the range; between the effectiveness of the Ermakov test and the time at which the signal exits at the minimum in the feedback test; between the jump in length and time running at 60 m (Table 2).

Table 2

Interconnection of psychophysiological indicators and indicators of physical and technical readiness of young football players 12-13 years in the competitive period of the annual training cycle

Indicators	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1,00															
2	0,48	1,00														
3	0,17	0,64	1,00													
4	0,09	0,11	0,25	1,00												
5	0,04	-0,23	0,22	0,38	1,00											
6	0,00	0,31	0,02	-0,36	0,14	1,00										
7	-0,28	-0,72	-0,39	0,07	0,46	-0,30	1,00									
8	-0,47	-0,69	-0,39	0,05	0,54*	-0,12	0,84	1,00								
9	0,68*	0,02	-0,02	0,12	-0,18	0,27	-0,18	0,17	1,00							
10	0,22	0,15	-0,08	-0,11	-0,50*	-0,19	-0,31	-0,35	-0,07	1,00						
11	0,50*	0,53*	-0,12	-0,27	-0,69*	0,15	-0,37	-0,54	-0,09	0,44	1,00					
12	-0,28	-0,31	-0,31	-0,04	-0,09	-0,24	-0,01	0,12	0,01	0,07	-0,21	1,00				
13	0,06	-0,04	0,34	0,18	0,41	-0,03	0,03	-0,03	-0,24	-0,77*	-0,48	-0,12	1,00			
14	-0,04	0,25	-0,02	0,04	-0,24	0,01	0,01	-0,07	0,10	0,13	0,43	0,49	-0,34	1,00		
15	-0,41	-0,29	-0,05	0,13	0,51*	0,33	0,45	0,53	0,24	-0,56*	-0,42	0,16	0,35	0,31	1,00	
16	0,19	0,23	0,40	-0,23	0,46	-0,54*	-0,06	0,08	0,04	-0,49*	-0,13	-0,55*	0,39	-0,40	0,15	1,00

Notes: 1 - time of the latent period of a simple visual-motor reaction (ms); 2 - time of the latent period of the reaction of selecting 2 objects from 3 (ms); 3 - time of the latent period of the reaction of selecting 2 objects from 3 in the feedback mode (ms); 4 - the minimum signal exposure time in the test with feedback (ms); 5 - total test time with feedback (ms); 6 - time to reach the minimum signal exposure in a test with feedback (ms); 7 - work time on the second table in the Schulte test (s); 8 - work time on the fifth table in a Schulte test (s); 9 - run, 60 m (s); 10 - run, 1000 m (s); 11 - shuttle run 30m x 4 (s); 12 - pull-ups (number); 13 - jump from the spot (m); 14 - ball juggling (number); 15 - Strikes at a distance (m); 16 - Test "Vibir Button" (test Ermakova), 30 s (number); * - the relationship is reliable at $p < 0.05$

In young footballers 15-16 years in the preparatory period, the total number of reliable relationships between psychophysiological indicators and indicators of physical and technical preparedness is lower than that of young footballers 12-13 years in the preparatory and competitive periods. The total number of reliable relationships ($p < 0,05$) was 3: between shuttle run and the time of minimum signal exposure in the feedback test, the total time of the test with the feedback; between juggling a ball and impact on a range (Table 3).

In the competitive period, young footballers aged 15-16 have an increase in the total number of

reliable relationships between psychophysiological indicators and indicators of physical and technical preparedness compared with the preparatory period. The total number of reliable relationships ($p < 0,05$) was 11: between the Ermakov test and the time of a simple reaction, sometimes a complex reaction, sometimes a complex reaction in the feedback mode, the time to reach the minimum signal exposure in the feedback test, lump; between a jump from place to time and a simple and complex reaction; between the time of the shuttle run and the time of the minimum signal exposure in the feedback test (Table 4).



Table 3

Interconnection of psychophysiological indicators and indicators of physical and technical readiness of young football players 15-16 years in the preparatory period of the annual training cycle

Indicators	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1,00															
2	0,27	1,00														
3	0,02	-0,44	1,00													
4	0,06	-0,25	0,84	1,00												
5	0,09	-0,13	0,76	0,87	1,00											
6	-0,09	-0,33	0,22	-0,10	-0,05	1,00										
7	-0,03	-0,15	0,73	0,56	0,69	-0,04	1,00									
8	-0,31	-0,31	0,65	0,49	0,52	-0,21	0,82	1,00								
9	0,34	-0,31	-0,14	-0,48	-0,41	0,53	-0,21	-0,39	1,00							
10	0,09	-0,30	0,00	0,26	0,00	-0,08	-0,30	-0,36	-0,04	1,00						
11	-0,41	-0,15	-0,42	0,66*	0,82*	0,36	-0,50	-0,33	0,37	0,13	1,00					
12	-0,39	0,21	-0,37	-0,53	-0,39	-0,23	0,17	0,34	-0,14	-0,58	0,30	1,00				
13	0,46	0,24	-0,05	-0,17	0,01	-0,34	0,06	0,21	0,11	-0,49	-0,25	0,18	1,00			
14	0,20	0,43	-0,04	-0,19	-0,12	0,08	-0,01	0,10	-0,13	-0,30	0,13	0,18	0,52	1,00		
15	0,15	0,09	-0,16	-0,48	-0,39	0,14	-0,01	0,04	0,36	-0,14	0,50	0,32	0,49	0,69*	1,00	
16	-0,33	0,19	-0,05	-0,03	-0,10	0,07	0,18	-0,05	-0,07	0,20	0,33	0,17	-0,52	-0,20	0,10	1,00

Notes: 1 - time of the latent period of a simple visual-motor reaction (ms); 2 - time of the latent period of the reaction of selecting 2 objects from 3 (ms); 3 - time of the latent period of the reaction of selecting 2 objects from 3 in the feedback mode (ms); 4 - the minimum signal exposure time in the test with feedback (ms); 5 - total test time with feedback (ms); 6 - time to reach the minimum signal exposure in a test with feedback (ms); 7 - work time on the second table in the Schulte test (s); 8 - work time on the fifth table in a Schulte test (s); 9 - run, 60 m (s); 10 - run, 1000 m (s); 11 - shuttle run 30m x 4 (s); 12 - pull-ups (number); 13 - jump from the spot (m); 14 - ball juggling (number); 15 - Strikes at a distance (m); 16 - Test "Vibir Button" (test Ermakova), 30 s (number); * - the relationship is reliable at $p < 0.05$

Thus, in the competitive period in football players of 15-16 years, there is an increase in the number of relationships between psychophysiological indicators and indicators of physical and technical preparedness compared with the preparatory period. Compared to the competition period of footballers aged 12-13, players aged 15-16 have the same number of reliable relationships between psychophysiological indicators and physical and technical readiness indicators. But there is a greater number of interactions that reflect high-speed physical fitness and mobility of the nervous system, the ability to switch attention, the speed of a simple and complex reaction. The obtained data is a reflection of the process of formation of a specific type of football player, when the speed of neurodynamic processes is associated with high-speed and speed-strength physical qualities.

Discussion

The data obtained confirm the results of research Lyzohub et. al. (2016), Korobeynikov et. al.

(2012, 2016) on the differences in the development of the psycho-physiological functions of children of different ages. However, in our study, data were obtained regarding the dynamics of the relationship of psycho-physiological indicators with indicators of physical and technical readiness during a 3-month workout with football players of different ages. The data obtained are new in terms of identifying features of the dynamics of the relationship of psycho-physiological functions with indicators of physical and technical readiness of young football players.

The findings also confirm the results of studies that revealed the effects of various training programs on the level of physical and technical fitness of young football players (Arrieta, Castellano, Guridi, & Echezarra, 2017, Bolotin, & Bakayev, 2017, Jaafar, Abdul, & Ahmad, 2018), as well as anthropometric indicators (Alturo et al., 2018, da Silva et al., 2019). In our study, young football players trained using standard programs for football players of the corresponding age. In both age groups, there was a positive dynamics of the relationship of psycho-physiological indicators with indicators of physical and technical readiness.



Table 4

Interconnection of psychophysiological indicators and indicators of physical and technical readiness of young football players 15-16 years in the competitive period of the annual training cycle

Indicators	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1,00															
2	0,30	1,00														
3	0,49	-0,08	1,00													
4	0,61*	0,22	0,52	1,00												
5	0,06	0,49*	0,54*	0,02	1,00											
6	0,37	-0,08	0,46	0,30	0,62*	1,00										
7	0,02	0,14	-0,02	0,52	-0,36	-0,50	1,00									
8	0,15	0,14	0,03	0,57	0,02	-0,05	0,74	1,00								
9	0,41	-0,21	0,27	0,58*	0,11	0,12	0,44	0,60*	1,00							
10	0,27	0,13	0,24	0,41	-0,09	0,25	0,18	-0,15	-0,02	1,00						
11	0,31	0,25	-0,24	0,33	0,47	-0,02	0,12	0,22	0,09	-0,11	1,00					
12	-0,09	0,27	-0,46	-0,10	-0,09	0,02	-0,09	0,06	-0,55	0,04	0,28	1,00				
13	-0,63*	-0,42*	-0,19	-0,13	0,02	-0,25	0,22	0,16	-0,17	-0,29	0,27	0,09	1,00			
14	-0,13	0,35	0,01	-0,22	-0,20	0,01	-0,20	-0,37	-0,78	0,26	0,23	0,41	0,24	1,00		
15	-0,21	0,34	-0,64	-0,09	-0,29	-0,14	0,17	0,40	0,15	-0,32	0,36	0,18	0,14	-0,16	1,00	
16	-0,53*	-0,56*	-0,53*	-0,41	-0,28	-0,44*	0,06	-0,29	-0,13	0,12	-0,13	0,12	0,29	-0,11	-0,15	1,00

Notes: 1 - time of the latent period of a simple visual-motor reaction (ms); 2 - time of the latent period of the reaction of selecting 2 objects from 3 (ms); 3 - time of the latent period of the reaction of selecting 2 objects from 3 in the feedback mode (ms); 4 - the minimum signal exposure time in the test with feedback (ms); 5 - total test time with feedback (ms); 6 - time to reach the minimum signal exposure in a test with feedback (ms); 7 - work time on the second table in the Schulte test (s); 8 - work time on the fifth table in a Schulte test (s); 9 - run, 60 m (s); 10 - run, 1000 m (s); 11 - shuttle run 30m x 4 (s); 12 - pull-ups (number); 13 - jump from the spot (m); 14 - ball juggling (number); 15 - Strikes at a distance (m); 16 - Test "Vibir Button" (test Ermakova), 30 s (number); * - the relationship is reliable at $p < 0.05$

However, in the age group of 15–16 years, a change in the quantity and quality of the interrelations studied during 3 months of training is more pronounced than in the age group of 12–13 years. This may be due to the age characteristics of young football players, since in 15-16 years there is some mismatch in the interaction of various functions due to puberty, the change in psychophysiological functions occurs faster than in older ones (Lyzohub, Nechyporenko, Pustovalov, Suprunovych, 2016).

In studies Mikheev et. al. (2002) it was shown that the development of speed abilities is associated with an increase in myelination of nerve fibers and an increase in the amount of white matter in the brain, which contributes to an increase in the rate of impulse transmission along the nerve pathways. An increase in the reaction rate in various test modes is also due to an increase in the rate of impulse transmission through the nerve fibers. In this regard, we can conclude that by the age of 15-16 a specific neurodynamic type of football player is formed, which is characterized by a high level of

neurodynamic processes in combination with a high level of development of speed and speed-power capabilities.

Due to the interrelationships between psycho-physiological indicators and indicators of physical and technical preparedness, in the training process of young football players should pay attention to the development of reaction speed, speed of switching attention, speed of thinking in combination with the development of speed and speed-power qualities in physical training. This leads to an intensification of the processes of conducting the impulse along nerve fibers, and increasing the speed of response to various signals (Bos, Dijksterhuis, & Van Baaren, 2012, Hornberger, Chien, 2006, Sobko, Kozina, Iermakov, Muszkiet, Prusik, Cieślicka, & Stankiewicz, 2014).

Recommendations

Based on the obtained data, it is possible to give recommendations in the training process of young players to focus on the development of qualities that require the activation of



psychophysiological functions, especially - the reaction rate, the speed of switching attention, mental performance, etc. Psychophysiological functions are largely hereditary, and their development is difficult, therefore, emphasis should be placed on their development, since in adults the level of psychophysiological functions is more difficult to develop that can play a decisive role in improving the athlete in football.

Conclusions

1. In the preparatory period for young footballers of 12-13 years, the total number of reliable relationships between psychophysiological indicators and indicators of physical and technical preparedness was 12 interconnections. In the competitive period in young footballers of 12-13 years, the total number of reliable relationships between psychophysiological indicators and indicators of physical and technical preparedness remained unchanged, and also made 12 interconnections.

2. In young footballers aged 15-16 in the preparatory period, the total number of reliable relationships between psychophysiological indicators and indicators of physical and technical preparedness is lower than that of young players 12-13 years in the preparatory and competitive periods. In the competitive period of 15-16 year old football players there is an increase in the number of

interconnections between psychophysiological indicators and indicators of physical and technical preparedness compared with the preparatory period.

3. In footballers aged 15-16, there is an increase in the number of relationships in the competitive period that reflects the high-speed physical qualities and mobility of the nervous system, the ability to switch attention, the speed of a simple and complex reaction in comparison with the preparatory period and the results of testing the players 12-13 years.

4. The obtained data is a reflection of the process of formation of a specific type of football player, when the speed of neurodynamic processes is associated with high-speed and speed-strength physical qualities.

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